A08843

The Experimental Assessment of Goose Damage to Agricultural Crops

JANET KEAR, Ph.D. (Cantab.)

The Wildfowl Trust, Slimbridge, Gloucester, England

ABSTRACT

The interaction of British agriculture and wild geese is considered, with particular reference to the problem of whether grazing damage is caused to cereals and grass. Clipping experiments indicated that loss of winter foliage was not detrimental to harvest yield of silage grass, winter-wheat, and spring-barley, but information was further sought on the effects of geese trampling the crop and soil while feeding. Difficulties encountered in running grazing trials with wild geese, or with captive geese in Scotland, made it more useful to employ a tame flock in a controlled test series at an Experimental Farm near Hereford, England. Plots of winter-wheat and winter-oats were subjected to a very high goose usage of 11,000 hours per acre (24,000 per hectare) for three days a month from December to April, of spring-barley to a grazing in May, and of young grass to a grazing in October. The winter-wheat and spring-barley trials ran for three years and were checked by a further season's tests in Scotland. At harvest time no significant grain losses attributable to the grazing treatments could be found.

INTRODUCTION

Since early in the winter of 1961–62, the Wildfowl Trust has been carrying out investigations which attempt to establish whether wild geese cause any serious damage to agricultural crops in Britain. Interim reports have appeared in a number of journals, and the present paper brings together these results and adds more recent, unpublished ones.

The only species of wild geese that are found to be involved with agriculture to any large extent in the British Isles, and then mainly in Scotland, are the Greylag Goose (*Anser anser*) and the Pink-footed Goose (*A. brachyrhynchus*), the numbers and distribution of which are given by Boyd (1963). It was established by interrogation of farmers that opinions on the effects of their feeding on farmland can vary quite widely, from beneficial to detrimental, depending mainly on the time of year of their feeding (Kear, 1963*c*, 1964).

In general, wild geese arrive in autumn after the grain and potato harvests have been taken in, and their activities on these harvested fields were shown to be beneficial, as they clean up spilt grain and 'ground-keepers' (left-over potatoes), thus preventing the carry-over of pests such as cereal mildews and potato eel-worms. In addition, the birds remove seeds of weeds such as *Atriplex* and *Polygonum*, and the roots of *Equisetum* and *Agropyron repens* (Kear, 1963, 1965). On the other hand, the same goose species in a few places definitely do damage to turnips which are being increasingly left in the fields through the winter; and when geese graze in direct competition with stock for 'early bite' spring grass, there can be no doubt that they are depriving the farmer of much valuable feed (Kear, 1962, 1963; Kear & Rodger, 1963).

There were conflicting views on whether damage is ever done to growing cereals that geese graze in late winter and early spring (both autumn- and spring-sown), to young undersown grass in stubble fields, and to grass that is intended for summer pasturage or silage. Experimental attempts to settle these questions are grouped according to the three main classes of crops that they involve.

WINTER CEREALS

The possible damage by grazing geese could arise through two main causes: the direct effect of the removal of foliage at different stages of growth, and the indirect effect of trampling by geese which may puddle and 'cap' the soil surface—thus hindering normal aeration of the roots.

The effect of simple removal of foliage could quite easily be tested by hand clipping, and this was done as an initial essay. In the spring of 1962, a small controlled experiment in Fife examined the effects of very close clipping of Flamingo winter-wheat (Kear & Rodger, 1963). Three clipping treatments were used in a triplicated design which gave the following results:

Biological Conservation, Vol. 2, No. 3, April 1970 — © Elsevier Publishing Company Ltd, England — Printed in Great Britain

Treatment	*Mean yields of grain at 85 per cent dry matter*	
No clipping	37.4 cwt acre	4,694 kg ha
Clipping concluded early (clips in February and March only)	34.3 cwt acre	4,305 kg ha
Clipping concluded late (clips in February, March, April, and early May)	37.2 cwt acre	4,669 kg ha

(Least significant difference 4.9)

We may conclude that removal of foliage up to early May will have no undesirable effects. Straw yield was similarly unaffected by the clipping. It seems unlikely that grazing ever occurs much later than early May, as the geese usually migrate by the second week of that month.

It would obviously be much more difficult to reproduce the trampling effect by artificial means, and recourse must be had for this to actual grazing by geese. In a few cases it was possible to obtain total yield figures from fields grazed heavily by Greylags and Pinkfeet in winter, and to compare these with returns from near-by fields which were unvisited by geese (Kear, 1965*c*). For instance, in Perthshire, a Capelle winter-wheat crop gave 46 cwt of grain per acre (5,773 kg per ha) following apparent grazing damage in February, while another field of the same variety close-by gave only 44 cwt per acre (5,522 kg per ha) after no goose activity.

Lack of damage by grazing was shown even more strongly by the Virginia Commission of Game and Fisheries (Anon., 1952) in the case of three winter-wheat fields that had been planted to attract Canada Geese (*Branta canadensis*): 'When the crop was harvested, the field on which the 2,000 geese fed regularly made an average yield of 33 bushels to the acre (28·7 hectolitres per ha). The field where the lesser number of geese fed brought a crop averaging 25 bushels to the acre (21·8 hl per ha), and the field which the geese neglected entirely yielded only 18 bushels to the acre (15·7 hl per ha).'

In the State of Washington, the Game Department conducted a comparable experiment. Ten metal rings 20½ inches (52 cm) in diameter were laid in a wheat field in April, five of the rings being placed on good-looking green wheat where the geese had not been, while the other five were thrown where goose feeding had reduced the plants to ¼ inch (0·63 cm) in height. In July the wheat inside the rings was tied and cut. The first five bundles contained 275 grain-bearing heads while those from the spring-grazed areas contained 358, noticeably larger, heads (Anon., 1952).

In Michigan, the grain yields from winter-wheat fields that had been visited in March by Canada Geese were investigated by Pirnie (1954). He harvested a dozen 36-square-foot (2·50 sq m) samples from areas that had previously been grazed, or that had been protected from geese by half-open tents and therefore remained ungrazed. The yield from heavily-grazed samples varied between 9·8 and 31·6 bushels per acre (8·5 and 27·5 hl per ha), and that from ungrazed samples between 13·3 and 34·5 bushels per acre (11·6 and 30·0 hl per ha), but statistical evaluation failed to show that the geese had affected the yield. Pirnie suggested that site factors such as soil type, erosion, and standing water, were of far greater importance than the birds. For these reasons 'natural experiments' are unsatisfactory, because the effects of various factors impinging on the crop cannot be separated. The birds may be quite capable of selecting the better fields or better parts of any crop, and the yield might have been still higher without them. However, enclosure plots, 6 feet (1·8 m) square and somewhat similar to those used by Pirnie, were tried on a number of grass, winter-wheat, and spring-barley, fields in Scotland, that were known to have been favoured by geese in previous years (Kear, 1965*c*). These fenced plots effectively deterred geese, but for a number of reasons the trials were unsuccessful. Thus even in fields which the geese grazed, and in which the experimental areas were successfully protected from the birds, Hares were not excluded but actually grazed the plants down, probably selectively, quite as closely as the birds did outside.

The conclusion was reached that controlled grazing by a group of captive birds was the only feasible method of separating the various components involved in harvest yields. This has been tried already by Pirnie (1954) in the United States, using tame Canada Geese, and by Dobben (1953) in Holland, using Bean Geese (*Anser fabalis*) and Whitefronts (*Anser albifrons*).

Pirnie penned three birds in a circular area constructed of 27 feet (8·2 m) of fencing and moved this cage 12 times through a winter-wheat field in April. The length of time at any one site varied between 4 and 24 hours. This is equivalent to a pressure of 9,000 to 54,000 goose-hours per acre (20,000 to 125,000 per ha), although in seven of the 12 grazing trials, 10 hours of darkness were included, and some supplementary feed was given at first. In July, the grain within a 4-foot (1·2 m) square at the centre of each plot was harvested. The 12 grazing plots yielded at rates of 25 to 41 bushels per acre (21·8 to 35·7 hl per ha), while six ungrazed plots, 10 feet (3·0 m) away, yielded at 20 to 40 bushels (17·4 to 34·8 hl). Some of the highest yields came from areas where geese had

been kept the longest and trampling was theoretically most severe.

Of 32 experimental areas, each measuring 5 square metres, Dobben (1953) left some undisturbed whereas others were 'extensively' or 'lightly' grazed by 6 geese in January, February, or March. After extensive grazing of 19½ hours (equivalent to about 47,000 goose-hours per ha, but including a night of darkness), the ground was completely bare and no plants were visible; after light grazing of 6 hours (about 14,000 goose-hours per ha), parts of the shoots were still showing above the ground. As was pointed out, even damage of this second kind would have been reported as very serious and was most unlikely to occur in natural conditions. Yet at harvest time Dobben found no statistical difference in the grain production between heavily-grazed and ungrazed plots, or in 1,000-grain weights, although straw yield was reduced in the former by about 1,000 kg per hectare.

It was desirable to repeat these trials with the goose species involved in Scotland, and under the local climatic conditions. Whilst tame Pinkfeet and Greylags, accustomed to being handled and to feeding with each other, could easily be obtained from the collection at Slimbridge, they could not be transported across the border into Scotland owing to restrictions on poultry imposed by the Scottish Department of Agriculture. Therefore the main body of experiments was carried out at Rosemaund Experimental Husbandry Farm near Hereford, England. This is 40 miles (64 km) from Slimbridge, but any inconvenience was outweighed by the advantage of having fields of reasonably controlled variability in which to work.

The trial procedure is described in Kear (1965*a*): randomly arranged plots were marked out, measuring 8·5 feet (2·6 m, equivalent to 13 drill rows) × 30 feet (9·1 m) or 1/171 of an acre. From field observation it appeared that 9,000 goose-hours on the same acre (20,000 per ha) is maximal in any season in Britain, and a goose usage rather greater than this was the aim, therefore, in the experimental situation. Ten geese were penned for 6½ hours of daylight on each plot, giving the equivalent of about 11,000 goose-hours per acre (25,000 per ha). Grazing started at 08.45 hours, and after removal from the plots the geese were kept overnight in a shed with adequate water for washing. No supplementary food was given, and drinking water only was provided during the grazing period. Geese in Britain rarely roost on the fields, so an investigation of night-time trampling was felt to be unnecessary.

Grazing of the winter-wheat plots took place on three days of each month from December to April. From counts of droppings it seemed that the geese consumed equal amounts of foliage each day, but 'damage', [illegible]d on the basis of trampling, varied from moderate to very severe—depending mainly on the presence or absence of frost at the start of the grazing, and on the amount of rainfall during the day.

The results of three years' investigations into the effect of grazing on winter-wheat at Rosemaund Experimental Husbandry Farm are given in Table I.

TABLE I

Grain Yields (Corrected to 85 per cent Dry Matter) of Capelle Winter-sown Wheat Grazed by Captive Geese from December to April

Year	*Replication*	*Month of Grazing*					*No grazing*
		Dec.	*Jan.*	*Feb.*	*March*	*April*	
1963	1	23·7	*	*	21·5	22·8	24·6
	2	16·1	*	*	17·9	26·7	22·7
	3	15·0	*	*	22·8	22·7	27·6
1964	1	**	36·0	35·5	36·0	35·5	**
	2	35·0	35·0	**	34·0	**	34·0
	3	**	**	**	**	**	**
1965	1	38·5	32·5	34·1	37·0	38·5	43·4
	2	36·5	33·9	39·8	39·2	40·3	38·0
	3	37·0	26·5	21·0	28·9	37·2	23·6
Average of three years in lb/plot		28·8	32·8	32·6	29·6	31·9	30·5
Calculated in cwt/acre		44·1	50·2	49·9	45·3	48·8	46·4
Calculated in kg ha		5,535	6,300	6,263	5,685	6,125	5,823

* Complete snow-cover in January and February 1963.

** Combine harvester removed 10 plots in 1964

The work was again somewhat frustrated: snow-cover in January and February of 1963 prevented any grazing, and an unfortunate mistake by the harvester caused the simultaneous removal of the produce of ten plots in 1964. Differences in grain yield from the various plots were nevertheless examined, and the variance ratio was found to be non-significant at the 5 per cent level in both 1963 and 1965. This was despite nine mornings (out of 24) having a ground temperature below 32 F (0 C), and seven days of rain during the very severe grazing treatments. Certain plots did give low grain figures, and these can be matched to some extent with the climatic conditions: the lowest yields were obtained from those grazed in December 1962 and March 1963, immediately before and after the snow, but the whole crop gave a poor harvest for that year, possibly because of the severe winter. It is interesting to note that April grazing, which in 1965 was not completed until the 21st of the month, never seemed to affect the yield adversely. In 1963 the straw yield was unaffected by any of the treatments employed (Kear, 1965c).

In 1967 an opportunity arose to borrow ten geese from a Scottish aviculturist and so to check the negative English results under conditions obtaining in Scotland. As some of the lower yields had been on plots grazed in March, this month was selected for the 'spot check'.

The experiment was run for three days on a field of Capelle winter-wheat in Perthshire. Three control plots were used in the Scottish trials, because of the greater possibility of uneven soil effects on a non-experimental farm. All the grazed plots looked bare at the end of the trials; however, recovery was rapid, and by the end of May the grazed areas could hardly be distinguished, in appearance, from the control plots. The harvest results indicated a variability within the controls that was much greater than had been expected. Partly because of this, the grazed and control plots showed no significant difference in the time of ripening, in the weight of 1,000 harvested grains, or

Treatment	*Mean yields of grain at 85 per cent dry matter*
No grazing	42·8 cwt/acre = 5,372 kg/ha
Grazing in March	37·8 cwt/acre = 4,744 kg/ha

(Least significant difference 13·0)

in straw yield and, as in England, the differences in grain yield between grazed and control plots were also non-significant.

In the winter of 1962–63, a field of autumn-sown oats was given the same grazing treatment as the winter-wheat. Although winter-oats are not a common food, geese do take them occasionally (indeed, they did so during this particularly severe winter), and it seemed useful to obtain a single season's results. These, given in detail in Kear (1965c) and summarised in Table II, indicated that, on this crop also, very heavy grazing pressure had no significant effect at the 5 per cent level.

TABLE II

Grain Yield (Corrected to 85 per cent Dry Matter) of Powys Winter-sown Oats Grazed by Captive Geese in December, March, and April

Treatment and year	*Calculated Average*		
	lb/h plot	*in cwt/acre*	*in kg/ha*
No grazing	21·0	32·1	4,029
1962			
Grazed December	19·9	30·5	3,815
1963			
Grazed March	18·9	28·9	3,627
Grazed April	21·9	35·5	4,204
Total grazed	20·2	30·9	3,882

The fact that grazing of autumn-sown cereals does not cause *drastic* reduction in the ultimate yield of grain has long been recognised by farmers who put their stock on to the green cereal fields in late winter and early spring. Kinsey (1959) reviewed three years' experiments using sheep, run by the National Agricultural Advisory Service in the West Midlands of England. No reduction in grain-yield occurred when the grazing was completed by mid-April; in two of the years of trial, considerable reduction was produced by grazing until the end of April, but in 1957 plots were grazed from 12 to 19 April and again eaten bare on 1 May without affecting the grain harvest. A survey of 13 farms showed that, even after grazing pressures varying from 75 to 197 sheep-days per acre (0·4 ha) up to mid-April, yield was reduced in only three cases — two involving fairly severe grazing by cows, and one where no nitrogen top-dressing was applied after light grazing by sheep. On another eight of the 13 farms, the treatment actually increased yields—in one case of moderate grazing by sheep, by as much as 16·3 cwt per acre (2,046 kg per ha), because straw length was reduced following grazing and there was severe lodging on the ungrazed areas. Kinsey emphasised that lodging is considerably reduced or may be eliminated by spring grazing and this, in addition, helps to keep summer damage by small grain-eating birds to a minimum. Spring grazing by sheep was found to reduce straw yield by up to 30 per cent, this

was not the case in any of the cereals used in the *trials with geese* in Britain, although straw length may have been reduced.

SPRING CEREALS

Damage to spring-sown cereals (which geese sometimes graze in late April or early May) could arise, at least theoretically, for the same reasons that it might occur in autumn-sown crops—namely, by direct removal of leaf or by the effect of trampling. However, in comparison with winter-wheat, spring-barley might be much more vulnerable to damage because of its poorer tillering ability. This possibility was examined by clipping, and by three seasons' grazing trials on spring-barley in Herefordshire and one in Scotland. The procedure was the one already described, except that only one treatment was given, consisting of three days' grazing in late April or early May. To the best of my knowledge, no previous work on the grazing of sprouting spring-sown cereals has been published.

The clipping trials were run in Herefordshire, alongside the first season's grazing experiments; full results are given in Kear (1965*c*) and may be summarised as follows:

Treatment	*Mean grain yield at 85 per cent dry matter*
No clipping	44·2 cwt/acre = 5,547 kg/ha
Clipped 1–3 May	43·6 cwt/acre = 5,472 kg/ha

(Least significant difference 5·4)

Thus removal of herbage did not significantly reduce the yield of barley; nor did it affect the amount of straw produced.

Results of the three years' investigations into the effect of spring goose-grazing in England are given in Table III. Again, any differences in yield between the plots are not significant at the 5 per cent level, despite four frosty mornings (out of nine) and eight days during which there was rain. With barley, the state of ripeness is relatively easy to gauge because the ripening seed-heads bend over. By the end of July, the control plots were starting to ripen, while the grazed plots still showed little sign of this. However, at harvest time in early September, the ripeness of the grain, judged on dry-matter content, was the same for both treatments.

A trial in Scotland was run in 1967, using the loaned geese, on a spring-sown field of Vinter barley which was grazed for three days in the middle of May. Recovery was rapid, and at harvest the nitrogen contents and 1,000-grain weights were not significantly different in grazed areas and ungrazed controls. Grain yields were as follows:

Treatment	*Mean yield of grain at 85 per cent dry matter*
No grazing	31·2 cwt/acre = 3,916 kg/ha
Grazing 17–19 May	27·6 cwt/acre = 3,464 kg/ha

(Least significant difference 20·4)

Again the differences were non-significant—partly because of a very wide variation within the controls, which is reflected in a high standard error.

TABLE III

Grain Yield (Corrected to 85 per cent Dry Matter) of Rika Spring-sown Barley Grazed by Captive Geese Between 26 April and 3 May

Year and treatment	*Replications in lb/plot* 1	2	3	*Average in lb/plot*	*Calculated cwt/acre*	*Calculated kg/ha*
1963						
No grazing	29·3	28·7	28·6	28·9	44·2	5,547
Grazed	26·6	30·2	28·9	28·6	43·8	5,497
1964*						
No grazing	20·2	20·9	19·1	20·1	30·7	3,831
Grazed	20·0	18·6	16·6	18·4	28·1	3,527
1965						
No grazing	26·9	28·4	29·8	28·4	43·4	5,447
Grazed	28·2	26·6	27·3	27·4	41·9	5,259
Average of three years:						
				Control	39·4	4,945
				Grazed	37·9	4,757

* Crop suffered from mildew (30 per cent level of infection) and leather-jackets which reduced all yields.

GRASS

Spring damage by geese feeding on growing grass was not tested in the same way as that on cereals, because in the case of grass the amount of harvest yield at a later date is relatively unimportant. The main point at issue here is, instead, how much grass a goose actually consumes in competition with stock. For a free-flying goose this is unfortunately still not established, and only approximate calculations can be made. Jordan (1953) found that captive Canada Geese weighing on the average 7·20 lb (3·17 kg) took daily in winter 0·36 lb (0·18 kg) of small grains each. Pasture provides about four times as much water as grain and, on a dry-weight basis, roughly 75 per cent of the calories. Thus, if it is assumed that a bird's intake of calories tends to be similar whatever type of food is taken (*see* for example Gibb, 1957), a captive Canada Goose might be expected to consume 2·07 lb (0·91 kg) of fresh grass or 29 per cent of its body weight per day.

Pinkfeet and Greylags are lighter than Canadas (Kear, 1963*b*) and, taking into consideration the age and sex composition of the flocks, these species undoubtedly would consume less in total; but the additional energy required by a free-flying bird might raise the intake figure again to an average of around 2 lb (0·9 kg). On the other hand, a sheep weighing 160 lb (72 kg), will consume daily about 5 lb (2·3 kg) of dry matter when grazing average pasture (Woodman *et al.*, 1937), which is presumably the equivalent of about 25 lb (11·3 kg) wet-weight. Further investigations to establish how thoroughly geese digest grass and thereby how much they require per day are proceeding.

However, late-winter goose grazing might affect the yield of hay or silage on pasture that is left unstocked. This seemed unlikely to happen before March because, particularly in Scotland, much of the grass available in winter will be lost by frosting in any event. The matter was investigated by a clipping experiment on a 4th-year grass-and-clover mixture in Perthshire (Kear & Rodger, 1963). Plots were clipped with garden shears as close to the ground as possible between February and early May, and gave the following yields (indicated at the top of the next column) of dry matter on 29 May, when the field was cut for silage.

Treatment	*Mean yield of dry matter*
No clipping	25·9 cwt/acre = 3,251 kg/ha
Clipping concluded early (clips in February and March only)	23·9 cwt/acre = 3,000 kg/ha
Clipping concluded late (clips in February, March, April, and early May)	13·2 cwt/acre = 1,657 kg/ha

(Least significant difference 4·6)

Clipping that was concluded in March thus had no significant effect on yield, but the three plots which were cut in February, March, April, and early May, gave a significantly reduced cut. So it may be assumed that winter grazing as late as March will not affect the crop.

Trampling by geese on pasture in winter and early spring is not a problem, but geese have been accused of pulling grass out by the roots and of causing trampling damage when the plants are at an early stage of growth. This could occur in the autumn, when the birds feed on harvest grain-fields that are undersown with grass and clover.

This aspect was tested by a grazing trial, using the captive flock of Pinkfeet and Greylag Geese, run for three days on a young ley in Herefordshire. Details are given in Kear (1965*a*), and the summarised results are set out in Table IV. The yields of the plots harvested in May were similar both from the heavily grazed and the control (ungrazed) areas. Uprooted plants, and patches of bare earth from which plants might have been pulled, were entirely absent at the end of each grazing period. Thus it appears that, even with very high grazing usage, geese cause no damage to young grass in early autumn.

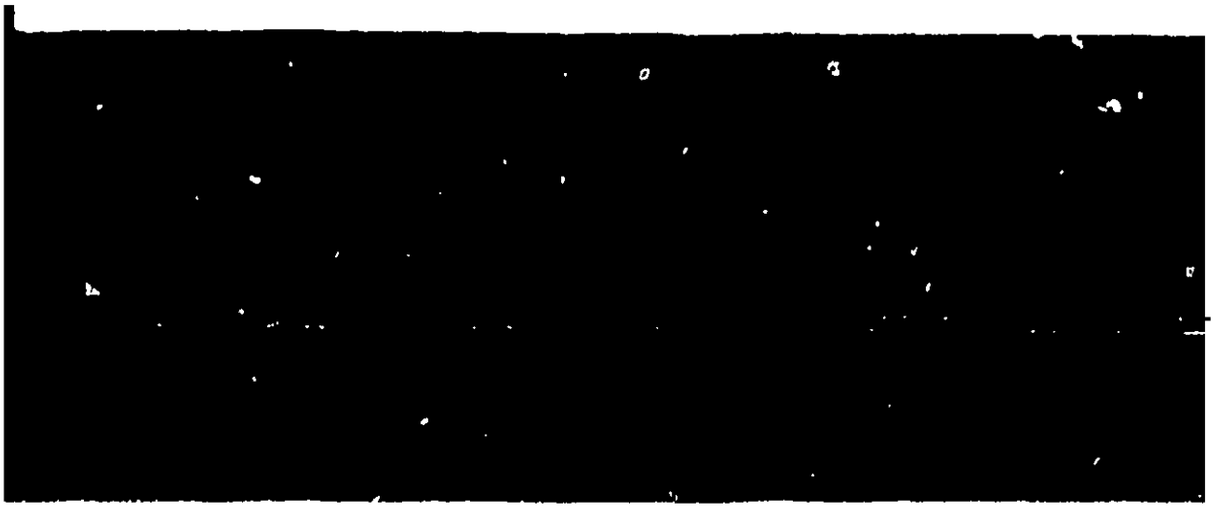
TABLE IV

Silage Yield of Grass and Clover Grazed by Captive Geese in October 1963

Treatment	*Mean yield of green matter in lb/plot*	*Average per cent of dry matter*	*Calculated yield of dry matter*
No grazing	36	17·8	9·8 cwt/acre = 1,230 kg/ha
Grazed	40	17·8	10·9 cwt/acre = 1,368 kg/ha

CONCLUSIONS

Migrant wild geese usually arrive in Britain too late in the year to damage unharvested crops, and at first confine their attention to stubble, young grass, and harvested potato fields, where they do more good than harm. Undoubtedly, damage occurs when geese graze in competition with stock for young grass, and in places where they eat turnips. During the midwinter period, wild geese tend to concentrate on grass or



winter-wheat, and the results of the extended series of trials described above have provided no evidence that they do damage at this time. Before the birds leave in April and May, they may graze young cereals; but again the trials have shown little effect on yield. A lowered silage yield may occur if grass is grazed in early May. Possibly, a very wet green-cereal field could be damaged by large flocks of geese feeding on it for a long time; but there is little evidence that this occurs, even with abnormal grazing densities. It is important that, after grazing has occurred, the usual nitrogen top-dressing and harrowing treatments be given to any cereal crop.

It would, obviously, be desirable to repeat the trials in Scotland – over a longer period and in an area where the soil variation between plots is not great. Some investigations into the botanical aspects of the subject (that is, into what goose grazing does to the plant, and why cereal grains are not reduced in size or number) might produce results of interest.

Special studies have meanwhile been made or are in progress on other aspects of the integration of wildfowl and agriculture, such as the fertilising value of the manure that geese leave behind on land which they graze (Kear, 1963*b*), the possible 'fouling' of pasture by their droppings (Rochard & Kear, 1968), the protection of crops from damage (Kear, 1963*a*, 1965*b*), and variations in traditional feeding-patterns with changes in agricultural practice (Kear, 1962, 1963, 1965). As a large part of the British wintering flocks breed in Iceland, the interaction of the Greylag Goose and Icelandic agriculture has been examined also (Kear, 1967).

ACKNOWLEDGEMENTS

It is a pleasure to thank the many people who have assisted this investigation over the years. The staff of the Rosemaund Experimental Husbandry Farm, near Hereford, England, were particularly helpful and kind. In Scotland, grazing trials were run on fields owned by J. Forsyth and J. Nicholson, and I am very grateful to them both. The captive goose flock was kindly supplied there by E. A. Maxwell. C. R. G. Campbell and J. B. A. Rodger harvested the plots in Scotland, and the latter did all the necessary assessment of yields. Mr Rodger has been a constant source of help and encouragement since the investigation started. Finally, Dr M. Owen kindly advised on the presentation.

The study has been made during the tenure by the author of a post financed by the Natural Environment Research Council at the Wildfowl Trust, Slimbridge, Gloucester, England.

References

ANON. (1952). Canada Geese benefit winter wheat. *Va. Comm. Game & Inl. Fish., Educ. Bull.*, 84, 1–2.

BOYD, H. (1963). The present status of the different species of wildfowl. Pp. 249–306 in *Wildfowl in Great Britain*. Nature Conservancy Monographs, 3, xiv + 368 pp.

DONIUS, W. H. VAN (1953). Landbouwschade door wilde ganzen. *Landbouwvoorlichting*, 10, 263–8.

GIBB, J. (1957). Food requirements and other observations on captive tits. *Bird Study*, 4, 207–15.

JORDAN, J. S. (1953). Consumption of cereal grains by migratory waterfowl. *Journ. Wildl. Mgt.*, 17, 120–3.

KEAR, J. (1962). Feeding habits of the Greylag Goose *Anser anser* on the island of Bute. *Scot. Birds*, 2, 233–9.

KEAR, J. (1963). The history of potato-eating by wildfowl in Britain. *Wildf. Trust Ann. Rep.*, 14, 51–65.

KEAR, J. (1963*a*). The protection of crops from damage by wildfowl. *Wildf. Trust Ann. Rep.*, 14, 66–71.

KEAR, J. (1963*b*). The agricultural importance of wild goose droppings. *Wildf. Trust Ann. Rep.*, 14, 72–77.

KEAR, J. (1963*c*). Wildfowl and agriculture. Pp. 315–28 in *Wildfowl in Great Britain*. Nature Conservancy Monographs, 3, xiv + 368 pp.

KEAR, J. (1964). Wildfowl and agriculture in Britain. *IUCN Publications, New Series*, 3, 321–31.

KEAR, J. (1965). Recent changes in Scottish barley acreages and the possible effect on wild geese. *Scot. Birds*, 3, 288–92.

KEAR, J. (1965*a*). The assessment by grazing trial of goose damage to grass. *Wildf. Trust Ann. Rep.*, 16, 46–47.

KEAR, J. (1965*b*). The reaction of captive Mallard to grain treated with a commercial bird repellent. *Wildf. Trust Ann. Rep.*, 16, 47–48.

KEAR, J. (1965*c*). The assessment of goose damage by grazing trials. *IUGB Congress Trans.*, 6, 333–9.

KEAR, J. (1967). Feeding habits of the Greylag Goose *Anser anser* in Iceland, with reference to its interaction with agriculture. *IUGB Congress Trans.*, 7, 615–22.

KEAR, J. & ROGER, J. B. A. (1963). Wild geese in east Scotland. *Scot. Agric.*, 43, 123–6.

KISSLY, C. (1959). Spring grazing autumn-sown cereals. *N.A.A.S. Quart. Review*, 46, 88–92.

PIRNIE, M.D. (1954). The grazing of dormant winter wheat by wild geese. *Mich. Agr. Exp. Station Quart. Bull.*, 37, 95–104.

ROCHARD, J. B. A. & KEAR, J. (1968). A trial to investigate the reactions of sheep to goose droppings on grass. *Wildfowl*, 19, 117–19.

[illegible] (1957). Amount of grass consumed by sheep on pastures of varying quality. *J. Agric. Sci.*, 27, 212.